WHAT IS CLAIMED IS:

1. A solid oxide fuel cell comprising:

a first perovskite solid electrolyte layer;

a fuel electrode provided on one surface of the first solid electrolyte layer;

an air electrode provided on the opposite side of the first solid electrolyte layer; and

a second solid electrolyte layer provided between the first solid electrolyte layer and the air electrode, and having a lower ratio of conduction by holes and higher ratio of conduction by oxygen ions of the conductive carriers of electrolyte such as ions, electrons, and holes than that of the first solid electrolyte layer under the operational condition of the solid oxide fuel cell.

2. The solid oxide fuel cell according to claim 1,

wherein assuming that oxygen ion conductivity, oxygen ion transport number and a thickness of the first solid electrolyte layer are respectively σp, tpo and Lp, and

oxygen ion conductivity, oxygen ion transport number and a thickness of the second solid electrolyte layer are respectively σc, tco and Lc, the formula below is satisfied:

$$Lp/(tpo \cdot \sigma p) > Lc/(tco \cdot \sigma c)$$

3. The solid oxide fuel cell according to claim 1,

wherein assuming that tpo is an oxygen ion transport number of the first solid electrolyte layer;

σc, Lc and tco are respectively total conductivity, a thickness and an oxygen ion transport number of the second electrolyte layer;

J, E0 are respectively a load electric current density and theoretical value of OCV (Open Circuit Voltage) of the solid oxide fuel cell,

the formula below is satisfied:

$$J \cdot Lc/(tco \cdot \sigma c) < (tco - tpo) \cdot E0$$

4. The solid oxide fuel cell according to claim 1,

wherein the first perovskite solid electrolyte layer is made of an LaGa-based perovskite compound represented by a composition formula of $La_{2-x-y}Ln_xA_yGa_{1-z}B_zO_{3-0.5(x+y+z)}$,

the Ln is one or more elements selected from the group consisting of Y, Yb, Gd, Sm and Nd,

the A is one or more elements selected from the group consisting of Sr, Ba, and Ca,

the B is one or two elements selected from the group consisting of Mg and Zn, and

the x is set in a range of 0.05 to 0.15, y in a range of 0.05 to 0.15, and z in the range a 0.05 to 0.25.

5. The solid oxide fuel cell according to claim 1, wherein the second solid electrolyte layer is made of stabilized zirconia, or alternatively a ceria based oxide.

6. A solid oxide fuel cell comprising:

a first perovskite solid electrolyte layer;

an air electrode provided on one surface of the first solid electrolyte layer;

a fuel electrode provided on the opposite side of the first solid electrolyte layer; and

a third solid electrolyte layer provided between the first solid electrolyte layer and the fuel electrode and having a lower ratio of conduction by electrons and protons and higher ratio of conduction by oxygen ions of the conductive carriers of electrolyte such as ions, electrons, and holes than that of the first solid electrolyte layer, under the operational condition of the solid oxide fuel cell.

7. The solid oxide fuel cell according to claim 6,

wherein assuming that oxygen ion conductivity, oxygen ion transport number and the thickness of the first solid electrolyte layer are respectively σp, tpo and Lp, and

oxygen ion conductivity, oxygen ion transport number and the thickness of the third solid electrolyte layer are respectively σa, tao and La, the formula below is satisfied:

$$Lp/(tpo \cdot \sigma p) > La/(tao \cdot \sigma a)$$

8. The solid oxide fuel cell according to claim 6,

wherein assuming that tpo is an oxygen ion transport number of the first solid electrolyte layer;

σa, La and tao are respectively total conductivity, a thickness and an oxygen ion transport number of the third electrolyte layer;

J, E0 are respectively a load electric current density and theoretical value of OCV (Open Circuit Voltage) of the solid oxide fuel cell,

the formula below is satisfied:

$$J \cdot La/(tao \cdot \sigma a) < (tao - tpo) \cdot E0$$

9. The solid oxide fuel cell according to claim 6,

wherein the first perovskite solid electrolyte layer is made of an LaGa based perovskite compound represented by a composition formula of $La_{2-x-y}Ln_xA_yGa_{1-z}B_zO_{3-0.5(x+y+z)}$,

the Ln is one or more elements selected from the group consisting of Y, Yb, Gd, Sm, and Nd,

the A is one or more elements selected from the group consisting of Sr, Ba, and Ca,

the B is one or two elements selected from the group consisting of Mg and Zn, and

the x is set in a range of 0.05 to 0.15 , the y in a range of 0.05 to 0.15, and the z in a range of 0.05 to 0.25.

10. The solid oxide fuel cell according to claim 6, wherein the second solid electrolyte layer is made of stabilized zirconia, alternatively a ceria based oxide.

11. A solid oxide fuel cell comprising:

a first perovskite solid electrolyte layer;

an air electrode provided on one side of the first solid electrolyte layer;

a fuel electrode provided on the opposite side of the first solid electrolyte layer;

a second solid electrolyte layer provided between the first solid electrolyte layer and the air electrode and having a lower ratio of conduction by holes and higher ratio of conduction by oxygen ions of the conductive carriers of electrolyte such as ions, electrons, and holes than that of the first solid electrolyte layer under the operational condition of the solid oxide fuel cell; and

a third solid electrolyte layer provided between the first solid electrolyte layer and the fuel electrode and having a lower ratio of conduction by electrons and hydrogen ions and higher ratio of conduction by oxygen ions of the conductive carriers of electrolyte such as ions, electrons, and holes than that of the first solid electrolyte layer under the operational condition of the solid oxide fuel cell.

12. The solid oxide fuel cell according to claim 11,

wherein assuming that oxygen ion conductivity, oxygen ion transport number and the thickness of the first solid electrolyte layer are respectively σp, tpo and Lp,

oxygen ion conductivity, oxygen ion transport number and the thickness of the second solid electrolyte layer are respectively σc, tco and Lc, and

oxygen ion conductivity, oxygen ion transport number and the thickness of the third electrolyte layer are respectively σa,tao and La, the formula below is satisfied:

$$Lp/(tpo \cdot \sigma p) > Lc/(tco \cdot \sigma c) + La/(tao \cdot \sigma a)$$

13. The solid oxide fuel cell according to claim 11,

wherein assuming that tpo is an oxygen ion transport number of the first solid electrolyte layer;

σc, Lc and tco are respectively total conductivity, a thickness and an oxygen ion transport number of the second electrolyte layer;

σa, La and tao are respectively total conductivity, a thickness and an oxygen ion transport number of the third electrolyte layer;

tcao is smaller oxygen ion transport number of tco or tao;

J, E0 are respectively a load electric current density and theoretical value of OCV (Open Circuit Voltage) of the solid oxide fuel cell,

the formula below is satisfied:

$$(tcao - tpo) \cdot E0 > J \cdot (Lc/(tco \cdot \sigma c) + La/(tao \cdot \sigma a))$$

14. The solid oxide fuel cell according to claim 11,

wherein the perovskite solid electrolyte is made of an LaGa-based perovskite compound represented by a composition formula of $La_{2-x-y}Ln_xA_yGa_{1-z}B_zO_{3-0.5(x+y+z)}$,

the Ln is one or more elements selected from the group consisting of Y, Yb, Gd, Sm, and Nd,

the A is one or more elements selected from the group consisting of Sr, Ba, and Ca,

the B is one or two elements selected from the group consisting of Mg and Zn, and

the x is set in a range of 0.05 to 0.15, the y in the a range of 0.05 to 0.15, and the z in a range of 0.05 to 0.25.

15. The solid oxide fuel cell according to claim 11, wherein the second solid electrolyte layer is made of stabilized zirconia, or alternatively a ceria-based

compound, and the third solid electrolyte layer is made of stabilized zirconia, or alternatively a ceria-based compound.